Investigating radiation damage experienced by Gaia's detectors

Other

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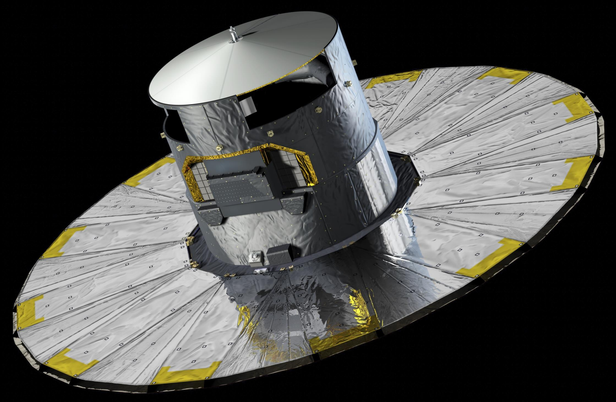
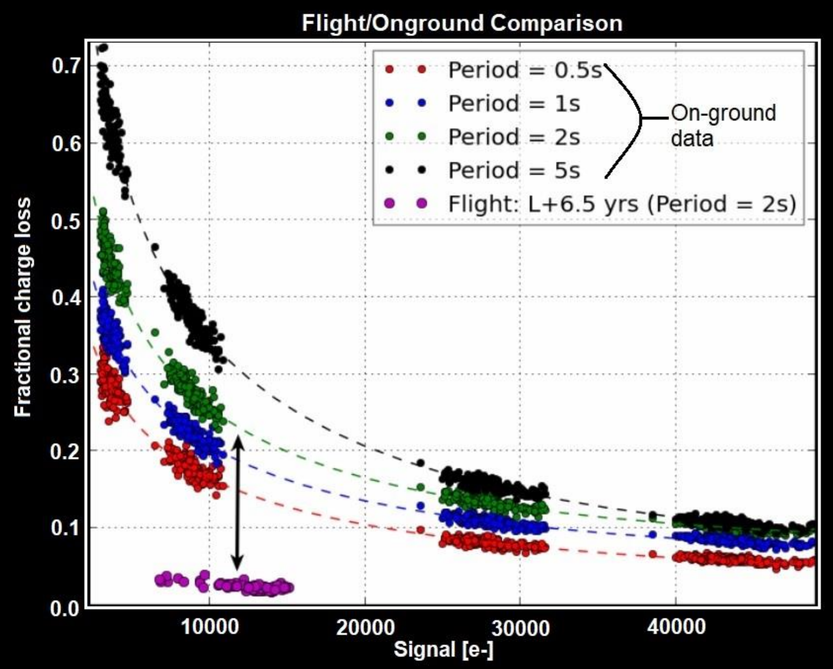
Gaia spacecraft

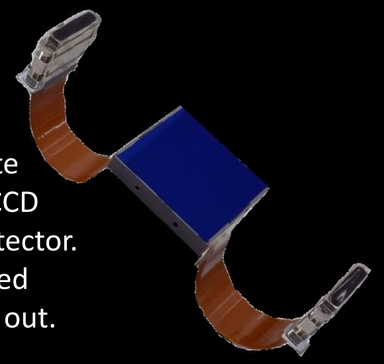


- The spacecraft is a European Space Agency observatory.
- Its aim is to chart out a map of the Milky Way by taking accurate measurements of over 1 billion stars.
- It has a focal plane of 106 charge-coupled devices to accomplish its mission.



Charge-Coupled Devices

- CCDs are digital imagers, used in many past and future space missions
- Photons from stars generate electron-hole pairs in the CCD when they arrive at the detector.
- The electrons are transferred across the device and read out.



Research problem

- In-orbit, the impact of radiation damage on Gaia has been much less than what was previously predicted from on-ground tests.
- Several different factors, such as background light or the energies of interstellar particles, are known to affect the radiation damage impact by different amounts.
- The goal of the project is to quantify the impact of all the different factors, in the context of Gaia.
- This will help us obtain a better understanding of CCD performance and radiation damage which will be beneficial for the planning and development of future space missions.

Project tasks

- We have been investigating both in-flight and on-ground data to better understand the behaviour and the effects of radiation on the devices.
- We will also quantify the trap defect properties in both sets of data and understand the differences behind them.

Radiation – sources and effects

- Outside the Earth's atmosphere, spacecraft are exposed to a large flux of highly energetic particles.
- The biggest sources are galactic cosmic rays and solar radiation.
- The high-energy particles can knock atoms out of the CCD's semiconductor lattice to form vacancies in the Silicon.
- These vacancies can combine with impurities to form trap defects.
- Trap defects can capture electrons from signals which causes charge loss and the formation of charge tails behind the data.

Preliminary results

- After 6 years in orbit, radiation damage on the Gaia CCDs is still an order of magnitude less as compared to the results from the laboratory tests.
- In-flight levels of background light have been measured to reduce the charge loss by up to a factor of 2, which is significant but not enough to explain the discrepancy.
- Different in-flight devices measure different amounts of charge loss and radiation damage accumulation.

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